Math 211: Ordinary Differential Equations (ODE) and Linear Algebra

(last updated: 2020-01-12)

Disclaimer

The policies of this syllabus are subject to change with reasonable advance notice.

Course Description

If mathematics is the language of the universe, the language of ODE is a ubiquitous dialect. Many important, diverse phenomena from nature turn into differential equations when mathematically modeled. We can often either solve these equations or give partial descriptions of their solutions, which helps us predict or approximate unknown features of the phenomena. For instance, the effects on population of the introduction of a new predator into an environment can be modeled by a differential equation, for which the solution can tell us whether the predator and prey can coexist perpetually or if, given enough time, one of the species will die out. We will study some fundamental methods for describing and finding solutions to differential equations, learn when to apply a particular method, and practice solving ODE and systems of ODE.

Course Objectives and Expected Learning Outcomes

We aim by the end of the course for you to be able to…

…identify ODE when they arise outside the math classroom.
…judge quickly whether an ODE is easy, difficult, or impossible to solve.
…solve first-order ODE by a variety of techniques.
…use fundamental linear algebra concepts and explain how they relate to ODE.
…analyze second-order ODE, linear systems of first-order ODE, and phase portraits.
…linearize nonlinear systems of first-order ODE and explain why you do.
…solve ODE of various order using the Laplace Transform.
…explain each step of solving an ODE to calculus students who have not yet taken ODE.
…explain how ODE describe phenomena in useful and beautiful ways.
…imagine situations in which ODE describe phenomena in your tangible surroundings.

Couse Information

Textbook

Most of the material we will study comes from

- *Differential Equations & Linear Algebra*, Second Edition, by Farlow, Hall, McDill, West

Below we will refer to this as ‘Farlow’. You are not required to purchase a copy of the textbook. Your learning will be well served if you secure access to material covering the following topics:

1. First-order ODE
2. Linearity
3. Linear Algebra
4. Higher-order linear ODE
5. Linear transformations
6. Linear systems
7. Nonlinear systems
8. Laplace transform

Logistics

Class time: 9:00am-9:50am, MWF
Classroom: RZR 119
Office hours: TBD

Instructor Information

Instructor: Ethan Gwaltney
Office: HBH 47 (basement)
Email: ethan.gwaltney@rice.edu

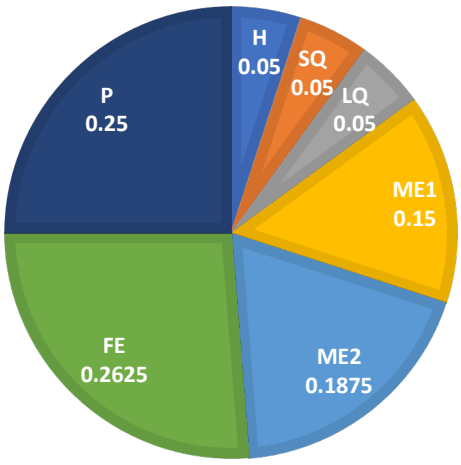
Grading Policy

We will assess progress using the following tools:

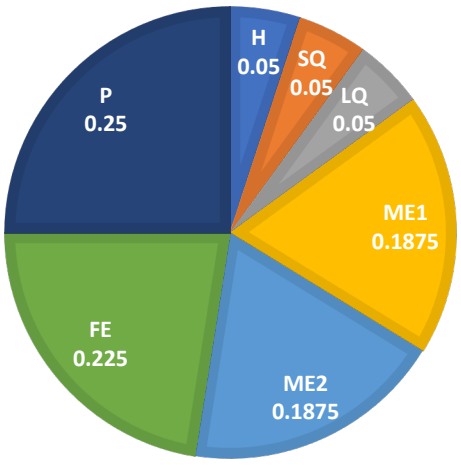
1. Homework (H). Homework will be assigned daily and will be due at the beginning of the subsequent class. Late homework will not be accepted. Homework will be graded using a 'reasonable attempt' rubric. The homework is intended to be analogous to the 'immersive' aspect of a language learning course since math *is* a language, in a sense.
2. Quizzes (Q). There will be an in-class quiz most class periods. Quizzes will be one of two sorts: short quizzes (SQ) and long quizzes (LQ). Short quizzes are 1 to 2-minute quizzes designed to help us clarify key ideas. Long quizzes are 5 to 15-minute quizzes designed to serve as practice for exams.
3. Exams (E). There will be two midterm exams (ME) and one final exam (FE). The midterm on which you receive higher marks we will call ME2, the one on which you receive lower marks, ME1. ME1 will be worth less that ME2 in your final grade distribution (see the chart below). See below for exam dates.
4. Projects (P). You will complete a series of small projects throughout the course. Projects will provide alternative media (writing, presentation, research, speaking, etc.) by which you can demonstrate your understanding to help counterbalance the 'false negatives' in assessment produced by test anxiety and other testing variables less interesting to me than your understanding of ODE and linear algebra. They also offer opportunities to develop skills important to facility in math, such as talking about math coherently. Projects also offer a venue in which you can connect class material to ODE in the world. More details on these projects will come as they are assigned (e.g., rubrics).

How is your grade calculated? Your final average is determined by the above assessments by the maximum of the following distributions:

GRADE DISTRIBUTION 1



GRADE DISTRIBUTION 2



Absence Policy
You are strongly encouraged, but not required, to attend class. As I will sometimes ask you to collaborate with your peers both inside and outside the classroom, please keep in mind the disservice you do your peers by failing to attend in addition to the disservice you do yourself.

Rice Honor Code

As a student at Rice University, you pledge to uphold the Rice Honor Code, of which you can remind yourself in the Honor System Handbook.

On homework, all resources are permitted. In particular, you are strongly encouraged to work with one another. The purpose of the homework is to internalize the language and practice of differential equations, which is often best facilitated in communication with peers.

On quizzes and exams, no external resources are permitted. The purpose of quizzes and exams is to help you see what you can do so far and what you need to work on, as well as to help me, as instructor, see where the course has catalyzed your learning and where it could do so better.

Hospitality

My ideal for the classroom is one in which every student is excited about the course and feels welcome. We might think of me as a host—I set the tone and decide the meal, as it were, and, if I'm a good host, I make you feel welcome. This vision motivates several of the design elements for the course (e.g., grading policy). If you have ideas on how the course might be more hospitable, please email me with subject "Hospitality" If you'd prefer to remain anonymous, use the following email account:
Address: anonymousowl.211@gmail.com
Password: Math211Spring2020

Students with Disabilities
If you are a student with a documented disability that requires accommodation, I encourage you to contact the Rice Disability Resource Center (adarice@rice.edu; Allen Center, Room 111) and me (ethan.gwaltney@rice.edu).

Resources

Potentially helpful resources:

- Past exams can be found on the Calculus Resources page on Canvas.
- Graduate students from the math department hold help sessions Monday through Thursday for two hours at a time. Time(s) and location(s) to be determined.
- For help with projects involving writing or presenting, consider visiting the Rice Center for Academic and Professional Communication, a free resource to all Rice students.

See the back of this page for a preliminary schedule of course topics and events!

Calendar

Below is a preliminary schedule of class topics and events. Section numbers and exercise numbers refer to Farlow unless indicated otherwise. Exercises are *assigned* on the date of the line on which they appear and are *due* the next class. Days with short quizzes are indicated in purple and days with long quizzes are indicated in orange. Project due dates are indicated in green.

Day	Date	Topic(s)	Sections	Exercises // Projects Due
M	13 Jan	Modeling Dynamical Systems	1.1	#7 //
W	15 Jan	Analysis of Slope Fields	1.2	#7,15 //
F	17 Jan	Separation of Variables	1.3	#5,7,9,17 //
W	22 Jan	Picard's Theorem for Existence & Uniqueness of Solutions	1.5	#1,7,9,20 // Why I'm still in school
F	24 Jan	Linearity	2.1	#5,7,13,15,43,45 //
M	27 Jan	First-order Linear ODE	2.2	#3,9,19,23,33 //
W	29 Jan	Solving FOL ODE in Applications	2.3-2.4	2.3#31 and 2.4#17 or #21//
F	31 Jan	Finite Matrices	3.1	// ODE Scavenger Hunt
M	3 Feb	Row Reduction of Matrices	3.2	//
W	5 Feb	Invertible Matrices	3.3	//
F	7 Feb	Determinant	3.4	//
M	10 Feb	Vector Spaces	3.5	//
T	11 Feb	**First Midterm Written Exam**	1.1-3.4	7-9pm, location TBD
W	12 Feb	Bases & Dimensions of Vector Spaces	3.6	//
M	17 Feb	Solving Constant Coefficient Second Order Linear ODE	4.2	//
W	19 Feb	Autonomous ODE and Phase Lines	2.5	//
F	21 Feb	Complex Roots of the Characteristic Equation	4.3	//
M	24 Feb	Method of Undetermined Coefficients	4.4	//
W	26 Feb	Variation of Parameters	4.5	//
F	28 Feb	Linear Transformations	5.1	//
M	2 Mar	Injectivity, Surjectivity, Rank, Kernel	5.2	// Matrices & Vector Spaces: A Summit
W	4 Mar	Eigenvalues & Eigenvectors	5.3	//
F	6 Mar	Coordinatization	5.4	//
M	9 Mar	Diagonalization	5.4	//
W	11 Mar	Linear Systems of ODE	6.1	//
F	13 Mar	Systems with Real Eigenvalues	6.2	//
M	23 Mar	Systems with Complex Eigenvalues	6.3	//
W	25 Mar	Systems with Complex Eigenvalues	6.3	//
F	27 Mar	Stability	6.4	//
M	30 Mar	Decoupling	6.5	//
T	31 Mar	**Second Midterm Written Exam**	3.5-6.3	7-9pm, location TBD
W	1 Apr	Matrix Exponential	6.6	//
F	3 Apr	Matrix Exponential	6.6	//
M	6 Apr	Nonlinear Systems of ODE	7.1	//
W	8 Apr	Linearization	7.2	//
F	10 Apr	Laplace Transform	8.1	//
M	13 Apr	Using the Laplace Transform	8.2	//
W	15 Apr	Step-function, delta-function	8.3	// ODE Hunt Results Presentation
F	17 Apr	Convolutions	8.4	//
M	20 Apr	Laplace Transforms for Linear Systems	8.5	//
W	22 Apr	Student ODE Presentations		
F	24 Apr	Final Review		